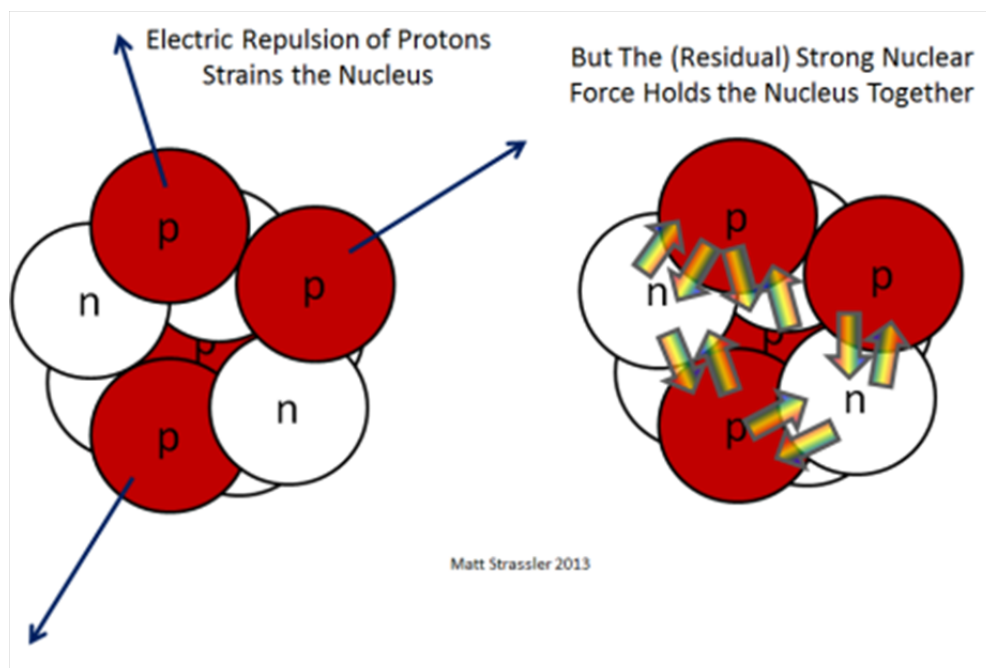



Nuclear Energy:

- Nuclear Stability
 - Depends on inter-nuclear forces acting on protons and neutrons
 - Protons have charge; electric force tries to separate protons
 - Strong force holds protons/neutrons together

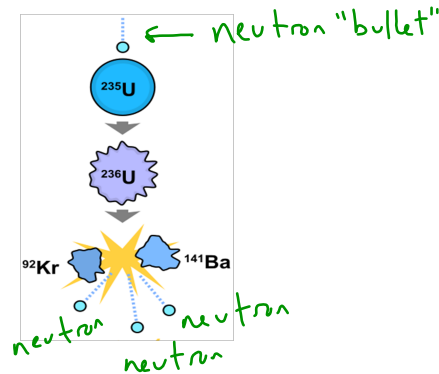


																							
H																		He					
Li		Be																B	C	N	O	F	Ne
Na		Mg																Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr						
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe						
Cs	Ba	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn						
Fr	Ra	Lr	Rf	Db	Sg	Bh	Hs	Mt	Uun	Uuu	Uub											Uuq	
		La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb								
		Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No								

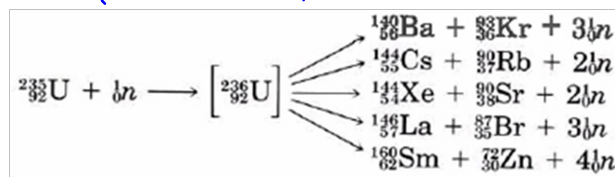
- Unstable when too many protons or neutrons → atom will split to "try" to become stable
- Any atom with more than 83 protons is always unstable

• Fission:

- Process where a nucleus splits into 2 or more smaller fragments, releasing neutrons and energy
- Happens in large nuclei



- Multiple pathways for nuclei to decay.
- 3 products are produced in all cases



• Energy Released

- In a fission reaction, mass decreases \rightarrow energy is released

$$- E = mc^2 \quad (c = 3 \times 10^8 \text{ m/s})$$

speed of light

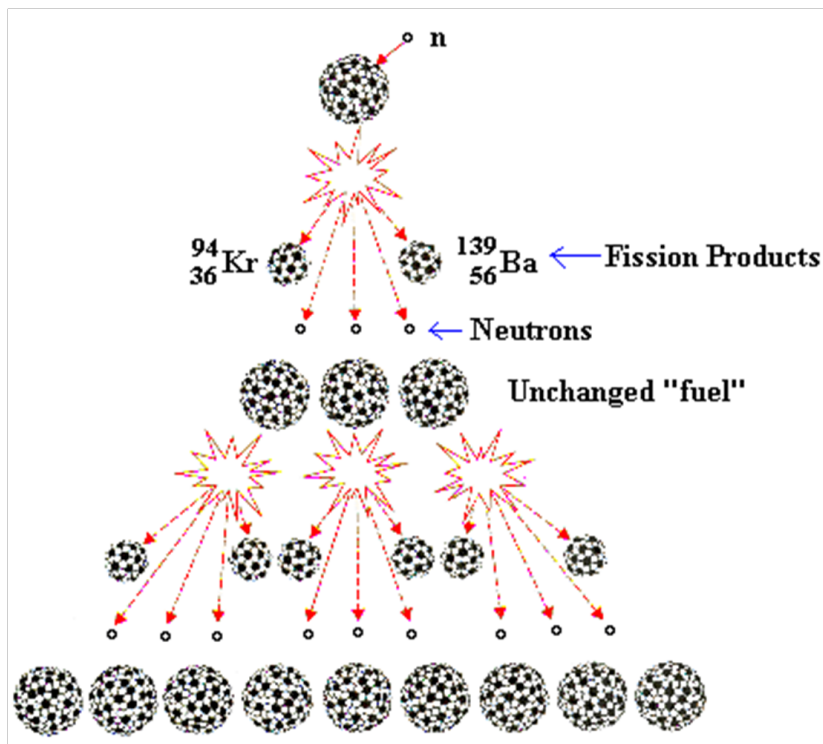
- Converting 1 kg of ${}^{235}\text{U}$ into energy:

$$E = (1 \text{ kg})(3 \times 10^8 \text{ m/s})^2 \quad (3 \times 10^8)(3 \times 10^8) \\ = 9 \times 10^{16} \text{ J}$$

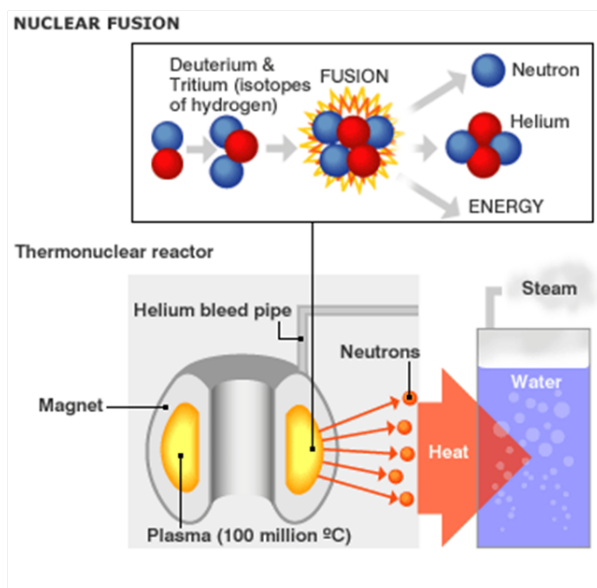
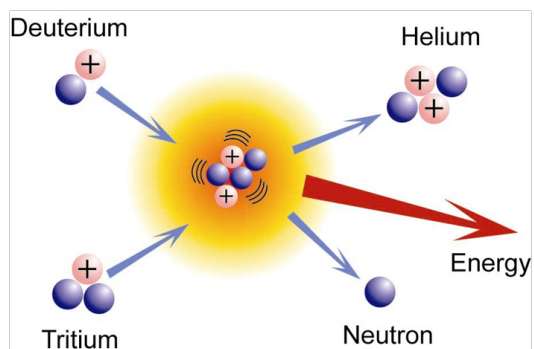
- Compared to burning 1 kg of coal:

$$E = 3.1 \times 10^7 \text{ J}$$

- Chain Reactions:
 - Repeating fission process
 - Neutrons from one reaction cause another reaction
 - Controlled → power plant/submarine/aircraft carrier
 - Uncontrolled → nuclear weapons



- Fusion
 - 2 light nuclei combine to form a heavier nucleus
 - Simplest version



ENERGY RELEASE			
	CHEMICAL	FISSION	FUSION
REACTION	$C+O = CO_2$	$N+U^{235} = Ba^{143}+Kr^{91}+2n$	$^2H + ^3H = ^4He+n$
FUEL	COAL	UO ₂ (3% U-235 + 97% U-238)	Deuterium + Tritium
TEMPERATURE	700°K	1,000°K	100,000,000°K
ENERGY J/kg	3.3×10^7	2.1×10^{12}	3.4×10^{14}